

Clean version of claims, incorporating current amendments.
IN THE CLAIMS:

What is claimed is:

- 1 1. A mixer circuit for generating an IF output responsive to an RF input and a LO drive source,
2 comprising:
3 a mixer core having a doubly balanced mixer including a first differentially coupled
4 transistor pair and a second differentially coupled transistor pair;
5 an RF input circuit coupled to the mixer core, the RF input circuit comprising:
6 an input inductor having a first terminal coupled to receive an RF input signal and
7 a second terminal;
8 a biasing resistor having a first terminal coupled to the second terminal of the
9 input inductor and a second terminal coupled to a first bias voltage;
10 a first input transistor having a control terminal coupled to the second terminal of
11 the input inductor, a second terminal, and a third terminal;
12 a second inductor having a first terminal coupled to the second terminal of the
13 first input transistor and to the first differentially coupled transistor pair, the second inductor also
14 having a second terminal coupled to a ground potential;
15 a supply resistor having a first terminal coupled to the second terminal of the first
16 input transistor and a second terminal coupled to a supply potential;
17 a first capacitor having a first terminal also coupled to the second terminal of the
18 first input transistor and a second terminal coupled to the second differentially coupled transistor
19 pair; and
20 a third inductor having a first terminal coupled to the second terminal of the first
21 capacitor and a second terminal coupled to the ground potential.
- 1 2. The mixer circuit according to Claim 1 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 npn transistors.

1 3. The mixer circuit according to Claim 1 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 pnp transistors.

1 4. The mixer circuit according to Claim 1 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 MOSFET transistors.

1 5. The mixer circuit according to Claim 1 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 MESFET transistors.

1 6. A mixer circuit for generating an IF output responsive to an RF input and a LO drive
2 source, comprising:
3 a mixer core having a doubly balanced mixer including a first differentially coupled
4 transistor pair and a second differentially coupled transistor pair, the mixer core coupled to
5 receive a LO drive signal, the LO drive signal having a plurality of harmonics;
6 a low noise RF input circuit coupled to the mixer core through a folded_cascode circuit,
7 the low noise RF input circuit coupled to receive an RF input signal, wherein the folded cascode
8 circuit further isolates the RF input circuit from the LO drive signal and the plurality of
9 harmonics.

1 7. A mixer as in Claim 6 wherein the folded cascode circuit comprises:
2 a first cascode transistor having an emitter terminal coupled to a second terminal of a
3 first capacitor and to a first terminal of a third inductor, a collector terminal coupled to the
4 second differentially coupled transistor pair and a base terminal,
5 a second cascode transistor having a base terminal coupled to the base terminal of the first
6 cascode transistor, an emitter terminal coupled to a first terminal of a second inductor and to an
7 emitter terminal of a first transistor and a collector terminal coupled to the first differentially
8 coupled transistor pair,
9 a second capacitor, having a first terminal coupled to the emitter terminal of the second
10 cascode transistor and a second terminal coupled to a second terminal of the first capacitor, the

11 base terminal of the first cascode transistor and to the base terminal of the second cascode
12 transistor,
13 a third capacitor, having a first terminal coupled to the emitter terminal of the first
14 cascode transistor and a second terminal coupled to the second terminal of the second capacitor,
15 a second biasing resistor having a first terminal coupled to the first terminal of the second
16 capacitor and a second terminal coupled to a second bias voltage.

1 8. A mixer as in Claim 7, wherein the low noise RF input circuit further includes a RF
2 feedback circuit, the RF feedback circuit comprising:
3 a second transistor having a base terminal coupled to the supply potential, an
4 emitter terminal coupled to the collector terminal of the first input transistor and a collector
5 terminal coupled to the first terminal of the supply resistor and to the first terminal of the first
6 capacitor,
7 a feedback resistor, having a first terminal coupled to the base terminal of the first
8 input transistor and a second terminal,
9 a second capacitor, having a first terminal coupled to the second terminal of the
10 feedback resistor and a second terminal coupled to the first terminal of the supply resistor.

1 9. A mixer as in Claim 7, wherein the mixer core further includes a tracking supply circuit,
2 the tracking supply circuit comprising:
3 a first diode-connected transistor having a cathode terminal coupled to the ground
4 potential and an anode terminal,
5 a second diode-connected transistor having a cathode terminal coupled to the
6 anode terminal of the first diode connected transistor and an anode terminal,
7 a third resistor having a first terminal coupled to the anode terminal of the second
8 diode connected transistor and a second terminal,
9 a first current supply having a first terminal coupled to the second terminal of the
10 third resistor and a second terminal coupled to the supply potential,
11 a loop amplifier having a first terminal coupled to the second terminal of the third
12 resistor and to the first terminal of the first current supply, a second terminal coupled to the
13 supply potential, a third terminal coupled to the ground potential and a fourth terminal,
14 a fourth resistor having a first terminal coupled to the fourth terminal of the loop
15 amplifier and a second terminal,

16 a second transistor having a collector terminal coupled to the second terminal of
17 the fourth resistor, a base terminal coupled to receive a first LO drive signal and emitter terminal,
18 a third transistor having a base terminal coupled to receive a second LO drive
19 signal, an emitter terminal coupled to the emitter terminal of the second transistor and a collector
20 terminal,
21 a fifth resistor having a first terminal coupled to the fourth terminal of the loop
22 amplifier and a second terminal coupled to the collector terminal of the third transistor
23 a second current supply having a first terminal coupled to the emitter terminal of
24 the second transistor and to the emitter terminal of the third transistor and a second terminal
25 coupled to the ground potential,
26 a first common collector amplifier having a base terminal coupled to the second
27 terminal of the fifth resistor and to the collector terminal of the third transistor, a collector
28 terminal coupled to the fourth terminal of the loop amplifier, and an emitter terminal coupled to a
29 first mixer core LO input,
30 a third current supply having a first terminal coupled to the emitter terminal of the
31 first common collector amplifier and a second terminal coupled to the ground potential,
32 a second common collector amplifier having a base terminal coupled to the
33 second terminal of the fourth resistor and to the collector terminal of the second transistor, a
34 collector terminal coupled to the fourth terminal of the loop amplifier and an emitter terminal
35 coupled to a second mixer core LO input,
36 a fourth current supply having a first terminal coupled to the emitter terminal of
37 the second common collector amplifier and a second terminal coupled to the ground potential.

1 10. A mixer as in Claim 7, wherein the low noise RF input circuit further includes a
2 tracking mixer bias current circuit coupled to the second bias input terminal, the tracking mixer
3 bias current circuit comprising:
4 a third resistor having a first terminal coupled to the supply potential and a second
5 terminal,
6 a first diode connected transistor having a anode terminal coupled to the second terminal
7 of the third resistor and a cathode terminal,
8 a second transistor having a collector terminal coupled to the cathode terminal of the first
9 diode connected transistor, an emitter terminal coupled to the ground potential and a base
10 terminal,

11 a loop amplifier having a first terminal coupled to the emitter terminal of the first diode
12 connected transistor and to the collector terminal of the second transistor, a second terminal
13 coupled to the second bias voltage and a third terminal,

14 a fourth resistor having a first terminal coupled to the base terminal of the second [npn]
15 transistor and a second terminal coupled to the second terminal of the loop amplifier and to the
16 second bias voltage,

17 a bandgap voltage supply having a first terminal coupled to the ground potential and a
18 second terminal coupled to the third terminal of the loop amplifier.

1 11. A mixer circuit as in Claim 6, wherein the mixer core further includes a tracking supply
2 circuit, the tracking supply circuit comprising:

3 a first diode-connected transistor having a cathode terminal coupled to the ground
4 potential and an anode terminal,

5 a second diode-connected transistor having a cathode terminal coupled to the
6 anode terminal of the first diode connected transistor and an anode terminal,

7 a third resistor having a first terminal coupled to the anode terminal of the second
8 diode connected transistor and a second terminal,

9 a first current supply having a first terminal coupled to the second terminal of the
10 third resistor and a second terminal coupled to the supply potential,

11 a loop amplifier having a first terminal coupled to the second terminal of the third
12 resistor and to the first terminal of the first current supply, a second terminal coupled to the
13 supply potential, a third terminal coupled to the ground potential and a fourth terminal,

14 a fourth resistor having a first terminal coupled to the fourth terminal of the loop
15 amplifier and a second terminal,

16 a second transistor having a collector terminal coupled to the second terminal of
17 the fourth resistor, a base terminal coupled to receive a first LO drive signal and emitter terminal,

18 a third transistor having a base terminal coupled to receive a second LO drive
19 signal, an emitter terminal coupled to the emitter terminal of the second transistor and a collector
20 terminal,

21 a fifth resistor having a first terminal coupled to the fourth terminal of the loop
22 amplifier and a second terminal coupled to the collector terminal of the third transistor

23 a second current supply having a first terminal coupled to the emitter terminal of
24 the second transistor and to the emitter terminal of the third transistor and a second terminal
25 coupled to the ground potential,

26 a first common collector amplifier having a base terminal coupled to the second
27 terminal of the fifth resistor and to the collector terminal of the third transistor, a collector
28 terminal coupled to the fourth terminal of the loop amplifier, and an emitter terminal coupled to a
29 first mixer core LO input,

30 a third current supply having a first terminal coupled to the emitter terminal of the
31 first common collector amplifier and a second terminal coupled to the ground potential,

32 a second common collector amplifier having a base terminal coupled to the
33 second terminal of the fourth resistor and to the collector terminal of the second transistor, a
34 collector terminal coupled to the fourth terminal of the loop amplifier and an emitter terminal
35 coupled to a second mixer core LO input,

36 a fourth current supply having a first terminal coupled to the emitter terminal of
37 the second common collector amplifier and a second terminal coupled to the ground potential.

1 12. A mixer circuit as in Claim 6, wherein the low noise RF input circuit further includes a
2 RF feedback circuit coupled to the RF input circuit, the RF feedback circuit comprising:

3 a second transistor having a base terminal coupled to the supply potential, an
4 emitter terminal coupled to the collector terminal of the first input transistor and a collector
5 terminal coupled to the first terminal of the supply resistor and to the first terminal of the first
6 capacitor,

7 a feedback resistor, having a first terminal coupled to the base terminal of the first
8 input transistor and a second terminal,

9 a second capacitor, having a first terminal coupled to the second terminal of the
10 feedback resistor and a second terminal coupled to the first terminal of the supply resistor.

1 13. A quadrature mixer circuit for generating a quadrature IF output responsive to an RF
2 input and a quadrature pair of LO drive signals, comprising:

3 a mixer core having a first doubly balanced mixer including a first differentially
4 coupled transistor pair and a second differentially coupled transistor pair and a second doubly
5 balanced mixer including a third differentially coupled transistor pair and a fourth differentially
6 coupled transistor pair;

an RF input circuit coupled to the mixer core, the RF input circuit comprising:
an input inductor having a first terminal coupled to receive an RF input signal and
a second terminal;
a biasing resistor having a first terminal coupled to the second terminal of the
input inductor and a second terminal coupled to a first bias voltage;
a first input transistor having a base terminal coupled to the second terminal of
the input inductor, an emitter terminal, and a collector terminal;
a second inductor having a first terminal coupled to the emitter of the first
transistor and to the first differentially coupled transistor pair and to the third differentially
coupled transistor pair, the second inductor also having a second terminal coupled to a ground
potential;
a supply resistor having a first terminal coupled to the collector of the first
transistor and a second terminal coupled to a supply potential;
a first capacitor having a first terminal also coupled to the collector of the first
transistor and a second terminal coupled to the second differentially coupled transistor pair and to
the fourth differentially coupled transistor pair; and
a third inductor having a first terminal coupled to the second terminal of the first
capacitor and a second terminal coupled to the ground potential.

14. A quadrature mixer circuit for generating a quadrature IF output responsive to an RF
input and a quadrature pair of LO drive signals, comprising:
a mixer core having a first doubly balanced mixer including a first differentially coupled
transistor pair and a second differentially coupled transistor pair and having a second doubly
balanced mixer including a third differentially coupled transistor pair and a fourth differentially
coupled transistor pair; the mixer core coupled to receive a quadrature LO drive signal, the
quadrature LO drive signal having a plurality of harmonics;
a low noise RF input circuit coupled to the mixer core through a folded cascode circuit,
the low noise RF input circuit coupled to receive an RF input signal, wherein the folded cascode
circuit further isolates the RF input circuit from the quadrature LO drive signal and the plurality
of harmonics,
a first cascode capacitor, a first terminal of the first cascode capacitor coupled to the
emitter terminal of a first cascode transistor and a second node of the first cascode capacitor
coupled to the base terminals of the first cascode transistor and a second cascode transistor,

15 a second cascode capacitor, a first terminal of the second cascode capacitor coupled to the
16 base terminals of the first cascode transistor and the second cascode transistor and the second
17 node of the second cascode capacitor coupled to the emitter terminal of the second cascode
18 transistor.
19

1 15. A quadrature mixer as in Claim 14 wherein the cascode circuit comprises:

2 a first cascode transistor having an emitter terminal coupled to the second terminal of the
3 first capacitor and to the first terminal of the third inductor, a collector terminal coupled to the
4 second differentially coupled transistor pair and a base terminal,

5 a second cascode transistor having a base terminal coupled to the base terminal of the first
6 cascode transistor, an emitter terminal coupled to the first terminal of the second inductor and to
7 the emitter terminal of the first transistor and a collector terminal coupled to the first
8 differentially coupled transistor pair,

9 a second capacitor, having a first terminal coupled to the collector terminal of the first
10 cascode transistor and a second terminal coupled to the base terminal of the first cascode
11 transistor and to the base terminal of the second cascode transistor,

12 a third capacitor, having a first terminal coupled to the emitter terminal of the second
13 cascode transistor and a second terminal coupled to the second terminal of the second capacitor
14 and to the base terminal of the first cascode transistor and to the base terminal of the first cascode
15 transistor,

16 a second biasing resistor having a first terminal coupled to the second terminal of the
17 second capacitor and the first terminal of the third capacitor and a second terminal coupled to a
18 second bias voltage,

19 a third biasing resistor having a first terminal coupled to the second bias voltage and to
20 the second terminal of the second biasing resistor and having a second terminal,

21 a third cascode transistor having a collector terminal coupled to the fourth differentially
22 coupled transistor pair, an emitter terminal coupled to the second terminal of the third inductor
23 and to the emitter terminal of the first cascode transistor, and a base terminal,

24 a fourth cascode transistor having a base terminal coupled to the base terminal of the third
25 cascode transistor, a collector terminal coupled the third differentially coupled transistor pair and
26 an emitter terminal coupled to the emitter terminal of the second cascode transistor and to the
27 second terminal of the second inductor,

28 a fourth capacitor having a first terminal coupled to the emitter terminal of the third
29 cascode transistor and a second terminal coupled to the base terminal of the third and fourth
30 cascode transistors,

31 a fifth capacitor having a first terminal coupled to the second terminal of the fourth
32 capacitor and to the base terminals of the third and fourth cascode transistors and a second
33 terminal coupled to the emitter terminal of the fourth cascode transistor.

1 16. A quadrature mixer as in Claim 15 wherein the low noise RF input circuit further
2 includes a RF feedback circuit, the RF feedback circuit comprising:

3 a second transistor having a base terminal coupled to the supply potential,
4 an emitter terminal coupled to the collector terminal of the first input transistor and a collector
5 terminal coupled to the first terminal of the supply resistor and to the first terminal of the first
6 capacitor,

7 a feedback resistor, having a first terminal coupled to the base terminal of
8 the first input transistor and a second terminal,

9 a sixth capacitor, having a first terminal coupled to the second terminal of
10 the feedback resistor and a second terminal coupled to the first terminal of the supply resistor.

1 17. A quadrature mixer as in Claim 16, wherein the mixer core further includes a first
2 tracking supply circuit portion coupled to the In-Phase LO drive input terminals of the
3 mixer core and a second tracking supply circuit portion coupled to the Quadrature Phase
4 LO drive input terminals of the mixer core.

1 18. A mixer circuit as in Claim 17, wherein the first tracking supply comprises:

- 2 a. a first diode-connected transistor having a cathode terminal coupled to the ground
3 potential and an anode terminal;
- 4 b. a second diode-connected transistor having a cathode terminal coupled to the
5 anode terminal of the first diode connected transistor and an anode terminal,
- 6 c. a third resistor having a first terminal coupled to the anode terminal of the second
7 diode connected transistor and a second terminal;
- 8 d. a first current supply having a first terminal coupled to the second terminal of the
9 third resistor and a second terminal coupled to the supply potential;

- e. a loop amplifier having a first terminal coupled to the second terminal of the third resistor and to the first terminal of the first current supply, a second terminal coupled to the supply potential, a third terminal coupled to the ground potential and a fourth terminal;
 - f. a fourth resistor having a first terminal coupled to the fourth terminal of the loop amplifier and a second terminal;
 - g. a second transistor having a collector terminal coupled to the second terminal of the fourth resistor, a base terminal coupled to receive a first LO drive signal and emitter terminal;
 - h. a third transistor having a base terminal coupled to receive a second LO drive signal, an emitter terminal coupled to the emitter terminal of the second transistor and a collector terminal;
 - i. a fifth resistor having a first terminal coupled to the fourth terminal of the loop amplifier and a second terminal coupled to the collector terminal of the third transistor;
 - j. a second current supply having a first terminal coupled to the emitter terminal of the second transistor and to the emitter terminal of the third transistor and a second terminal coupled to the ground potential;
 - k. a first common collector amplifier having a base terminal coupled to the second terminal of the fifth resistor and to the collector terminal of the third transistor, a collector terminal coupled to the fourth terminal of the loop amplifier, and an emitter terminal coupled to a first mixer core LO input;
 - l. a third current supply having a first terminal coupled to the emitter terminal of the first common collector amplifier and a second terminal coupled to the ground potential;
 - m. a second common collector amplifier having a base terminal coupled to the second terminal of the fourth resistor and to the collector terminal of the second transistor, a collector terminal coupled to the fourth terminal of the loop amplifier and an emitter terminal coupled to a second mixer core LO input; and
 - n. a fourth current supply having a first terminal coupled to the emitter terminal of the second common collector amplifier and a second terminal coupled to the ground potential;
- and wherein the second tracking supply circuit portion comprises:

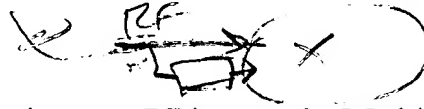
- 43 o. a third diode-connected transistor having a cathode terminal coupled to the ground
- 44 potential and an anode terminal;
- 45 p. a fourth diode-connected transistor having a cathode terminal coupled to the
- 46 anode terminal of the third diode connected transistor and an anode terminal;
- 47 q. a third resistor having a first terminal coupled to the anode terminal of the second
- 48 diode connected transistor and a second terminal;
- 49 r. a first current supply having a first terminal coupled to the second terminal of the
- 50 third resistor and a second terminal coupled to the supply potential;
- 51 s. a loop amplifier having a first terminal coupled to the second terminal of the third
- 52 resistor and to the first terminal of the first current supply, a second terminal
- 53 coupled to the supply potential, a third terminal coupled to the ground potential
- 54 and a fourth terminal;
- 55 t. a fourth resistor having a first terminal coupled to the fourth terminal of the loop
- 56 amplifier and a second terminal;
- 57 u. a second transistor having a collector terminal coupled to the second terminal of
- 58 the fourth resistor, a base terminal coupled to receive a first LO drive signal and
- 59 emitter terminal;
- 60 v. a third transistor having a base terminal coupled to receive a second LO drive
- 61 signal, an emitter terminal coupled to the emitter terminal of the second transistor
- 62 and a collector terminal;
- 63 w. a fifth resistor having a first terminal coupled to the fourth terminal of the loop
- 64 amplifier and a second terminal coupled to the collector terminal of the third
- 65 transistor;
- 66 x. a second current supply having a first terminal coupled to the emitter terminal of
- 67 the second transistor and to the emitter terminal of the third transistor and a
- 68 second terminal coupled to the ground potential;
- 69 y. a first common collector amplifier having a base terminal coupled to the second
- 70 terminal of the fifth resistor and to the collector terminal of the third transistor, a
- 71 collector terminal coupled to the fourth terminal of the loop amplifier, and an
- 72 emitter terminal coupled to a first mixer core LO input;
- 73 z. a third current supply having a first terminal coupled to the emitter terminal of the
- 74 first common collector amplifier and a second terminal coupled to the ground
- 75 potential;

- 76 aa. a second common collector amplifier having a base terminal coupled to the
77 second terminal of the fourth resistor and to the collector terminal of the second
78 transistor, a collector terminal coupled to the fourth terminal of the loop amplifier
79 and an emitter terminal coupled to a second mixer core LO input;
80 ab. a fourth current supply having a first terminal coupled to the emitter terminal of
81 the second common collector amplifier and a second terminal coupled to the
82 ground potential.

- 1 19. A quadrature mixer as in Claim 15, wherein the low noise RF input circuit further
2 includes a tracking mixer bias current circuit, the tracking bias current circuit
3 comprising:
4 a first resistor having a first terminal coupled to the supply potential and a second
5 terminal,
6 a first diode connected transistor having a anode terminal coupled to the second
7 terminal of the third resistor and a cathode terminal,
8 a second transistor having a collector terminal coupled to the cathode terminal of
9 the first diode connected transistor, an emitter terminal coupled to the ground potential and a
10 base terminal,
11 a loop amplifier having a first terminal coupled to the emitter terminal of the first
12 diode connected transistor and to the collector terminal of the second transistor, a second
13 terminal coupled to the second bias voltage and a third terminal,
14 a second resistor having a first terminal coupled to the base terminal of the second
15 transistor and a second terminal coupled to the second terminal of the loop amplifier and to the
16 second bias voltage,
17 a bandgap voltage supply having a first terminal coupled to the ground potential
18 and a second terminal coupled to the third terminal of the loop amplifier.

- 1 20. A mixer circuit for generating an IF output responsive to an RF input and a LO drive
2 source, comprising:
3 a mixer core having a doubly balanced mixer including a first differentially coupled [npn]
4 transistor pair and a second differentially coupled [npn] transistor pair;

5 a single ended RF input circuit coupled to receive an RF signal, the RF circuit coupled to
6 the mixer core, the RF circuit including means for providing an input impedance, means for
7 splitting a phase of the RF signal, and means for decoupling noise from the RF signal to the
8 mixer core.



1 21. A mixer circuit for generating an IF output responsive to an RF input and a LO drive
2 source, comprising:

3 a mixer core having a doubly balanced mixer including a first differentially coupled
4 transistor pair and a second differentially coupled transistor pair, the mixer core coupled to
5 receive a LO drive signal, the LO drive signal having a plurality of harmonics;

6 a low noise single ended RF input circuit coupled to the mixer core through a cascode
7 circuit, the low noise RF input circuit coupled to receive an RF input signal, wherein the cascode
8 circuit further isolates the RF input circuit from the LO drive signal and the plurality of
9 harmonics the RF circuit including means for providing an input impedance and means for
10 splitting a phase of the RF signal.

1 22. The mixer circuit according to Claim 6 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 npn transistors.

1 23. The mixer circuit according to Claim 6 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 pnp transistors.

1 24. The mixer circuit according to Claim 6 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 MOSFET transistors.

1 25. The mixer circuit according to Claim 6 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 MESFET transistors.

- 1 26. The mixer circuit according to Claim 13 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair, the third differentially coupled
3 transistor pair, the fourth differentially coupled transistor pair and the first input transistor
4 are all npn transistors.
- 1 27. The mixer circuit according to Claim 13 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair, the third differentially coupled
3 transistor pair, the fourth differentially coupled transistor pair and the first input transistor
4 are all pnp transistors.
- 1 28. The mixer circuit according to Claim 13 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair, the third differentially coupled
3 transistor pair, the fourth differentially coupled transistor pair and the first input transistor
4 are all MOSFET transistors.
- 1 29. The mixer circuit according to Claim 13 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair, the third differentially coupled
3 transistor pair, the fourth differentially coupled transistor pair and the first input transistor
4 are all MESFET transistors.
- 1 31. The mixer circuit according to Claim 14 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair, the third differentially coupled
3 transistor pair, the fourth differentially coupled transistor pair and the first input transistor
4 are all npn transistors.
- 1 32. The mixer circuit according to Claim 14 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair, the third differentially coupled
3 transistor pair, the fourth differentially coupled transistor pair and the first input transistor
4 are all pnp transistors.
- 1 33. The mixer circuit according to Claim 14 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair, the third differentially coupled

3 transistor pair, the fourth differentially coupled transistor pair and the first input transistor
4 are all MOSFET transistors.

1 34. The mixer circuit according to Claim 14 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair, the third differentially coupled
3 transistor pair, the fourth differentially coupled transistor pair and the first input transistor
4 are all MESFET transistors.

1 35. The mixer circuit according to Claim 20 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 npn transistors.

1 36. The mixer circuit according to Claim 20 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 pnp transistors.

1 37. The mixer circuit according to Claim 20 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 MOSFET transistors.

1 38. The mixer circuit according to Claim 20 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 MESFET transistors.

1 39. The mixer circuit according to Claim 21 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 npn transistors.

1 40. The mixer circuit according to Claim 21 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 pnp transistors.

1 41. The mixer circuit according to Claim 21 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
3 MOSFET transistors.

1 42. The mixer circuit according to Claim 21 wherein the first differentially coupled transistor
2 pair, the second differentially coupled transistor pair and the first input transistor are all
 MESFET transistors.